IPSC COMMENTS ON DRAFT REPORT ARE ENCLOSED.

Coal Burner Condition and Estimated Remaining Life Evaluation - IPP Units #1 & 2

DRAFT

Final Report

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IP7_004277

1.0 INTRODUCTION

The purpose of this EVALUATION IS ~~program, was~~ to provide technical support to Intermountain Power Service Corp. OPERATION (IPSC) IN EVALUATING ~~to evaluate~~ the existing condition and estimated REMAINING life of the coal fired burners on Units ~~X~~1 ~~& 2~~. These burners have had numerous modifications, adjustments, and repairs in ADDITION TO CHANGES IN OPERATING PARAMETERS ~~the first few years of~~ NCE INITIAL service. ~~and~~ IPSC is concerned that the remaining life has been significantly AFFECTED ~~shortened~~. A burner inspection was performed and the results and recommendations of that inspection are included in this report.

ISPLACED ?

Through (ONE WORD) out this report, references will be made to photograph numbers, for example, (Photo #1). All photographs referenced are attached in Appendix B, "PHOTOGRAPHS", at the end of this report.

→ MORE DETAIL ON WHY EER WAS AT THE SITE

TITLES OF THOSE WITH WHOM DISCUSSIONS WERE HELD:
MAINTENANCE
OPERATIONS
ENGINEERING
ETC.

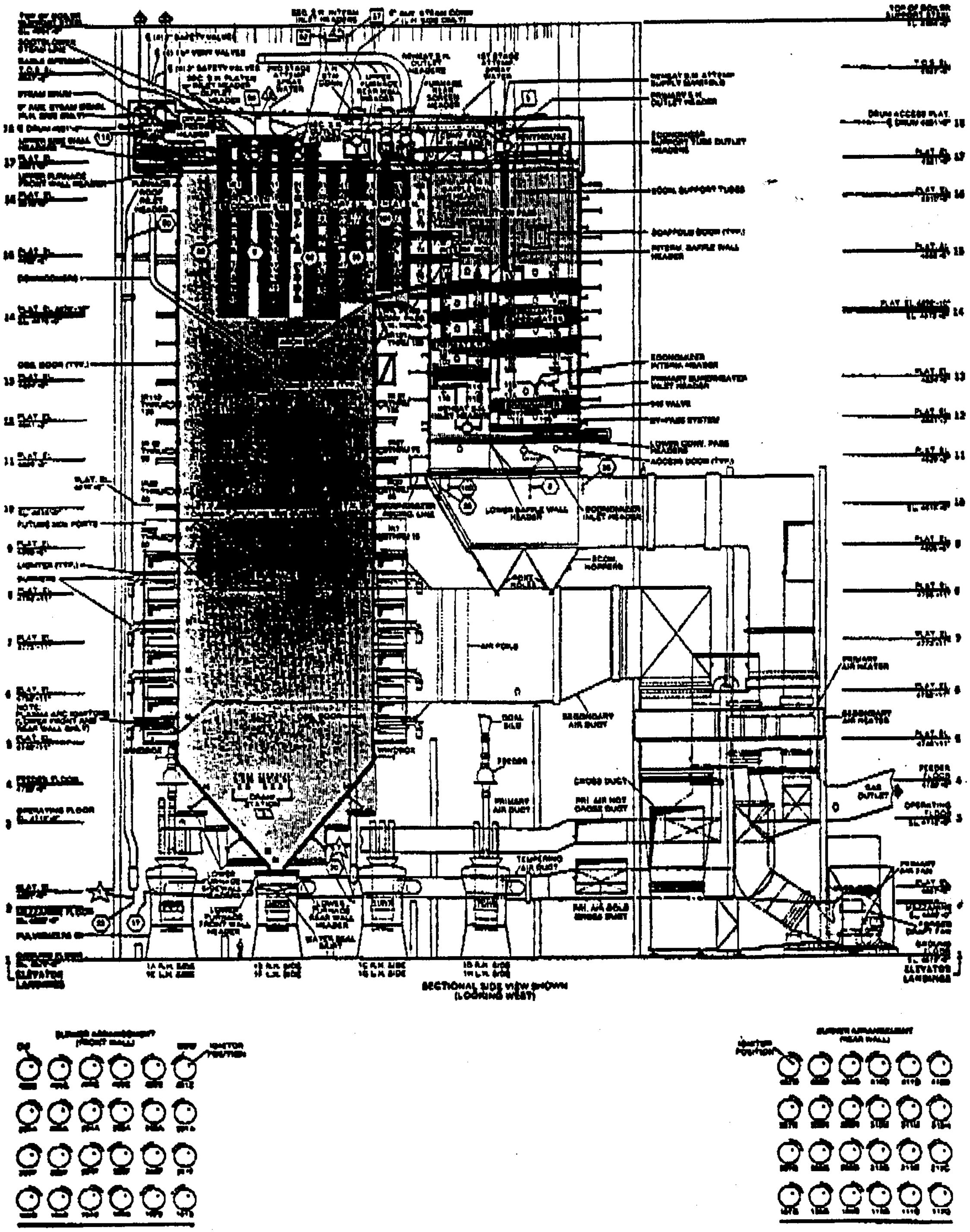
2.0 BACKGROUND INFORMATION

Intermountain ~~Power Project~~ GENERATING STATION Units #1 & 2 are indoor, balanced draft, parallel back-end, Carolina Type Radiant Boilers provided by the Babcock & Wilcox Company. Each unit ~~will~~ fires pulverized coal from forty-eight high input dual-register burners arranged in four rows of six burners on both the front and rear furnace walls. WHAT DOES THIS MEAN ? The burner windboxes are compartmented with air dampers located on each end. Furnace dimensions are 85 ft wide, 60 ft deep, and 299.5 ft from the lower wall header centerline to the drum centerline. Figure 1 illustrates the general BOILER arrangement of these units.

The ~~highest~~ maximum continuous rating of each ~~unit~~ STEAM GENERATOR is 6,600,000 lb/hr of main steam at 2640 psig and 1005°F at the superheater outlet with reheat steam flow of 5,285,000 lb/hr at 551 psig and 1005°F with a feedwater temperature of 555°F. The highest ~~turbine~~ MCR conditions are 6,480,000 lb/hr ~~main steam~~ at 2640 psig and 1005°F ~~with a reheat steam flow of 5,187,000 lb/hr at 550 psig and 1005°F~~ with a feedwater temperature of 554°F. The ~~customer's~~ "maximum capacity" load (100% - guaranteed load) ~~of~~ FOR each unit is 6,100,000 lb/hr of main steam at 2510 psig and 1005°F at the superheater outlet with a reheat steam flow of 4,925,000 lb/hr at 521 psig and 1005°F with a feedwater temperature of 545°F. Main and reheat steam temperatures are controlled to 1005°F from MCR down to 65% load (3,925,000 lb/hr) by a combination of ~~excess air~~ GAS BIASING, spray attemperation, ~~and~~ SOOTBLOWING AND EXCESS AIR. ~~gas biasing~~. The design pressures of the boiler, superheater, economizer, and reheater are 2975, 2975, 3050 and 750 psig respectively. (PRIORITY ORDER)

Each unit is capable of continuous operation on any of the seven customer specified coals "A" through "G" with coal "F" fired in a 50/50 blend with any other fuel. The 8 MPS-89G pulverizers were sized based on two other coals. Since some of the coals are classified as severe slagging and others are classified as severe fouling, the furnace and convection pass are designed on a severe slagging and fouling basis.

Each unit will be equipped with two cold primary air fans, two Ljungstrom secondary air heaters and two Ljungstrom primary air heaters.



INTERMOUNTAIN POWER PROJECT
UNIT NO. 1
LYNNDYL, UTAH

Figure 1
2-2

1 PARAGRAPH

The units are designed for cycling service and each HAS BEEN CONSTRUCTED ~~is initially provided~~ with a partial boiler by-pass system. The units can be operated in either a constant pressure, variable pressure or hybrid pressure mode of operation. ~~Unit design was based on normal turbine throttle pressure and variable turbine throttle pressure from 25% to 100% load.~~

These units have typically been base-loaded units with 96-98% load capacity since commercialization, but the units should still be capable of cycling service. ~~and the~~ THESE burners should remain FULLY adjustable, THROUGHOUT THE LOAD RANGE.

Unit #1 went into commercial service ~~in~~ ON May 10, 1986 and Unit #2 ~~in~~ ON July 1, 1987. Approximately one year after commercial service began, each unit received new Heavy Duty Air Registers on each upper level of burners due to the ~~failure~~ COMPLICATIONS of the original register. The original 70" dual register burner is illustrated in figure 2. The H.D. type register replacement corrects some of the problems experienced by the original burner. The door shaft diameter has been increased from 1/2 " to 3/4". The door shafts are fixed in place and the door rotates on the shaft. The linkage has been moved from behind the rear plate to the center of the register, and is not affected by the expansion of the rear plate. These changes have simplified the burner and HAS improved its operation.

CTUAL
ATES
IAILABLE

Thermocouples SUPPLIED BY THE CUSTOMER were attached to the throat sleeve, register rear plate, inner air sleeve, and coal nozzle TO MONITOR COOLING AIR REQUIREMENTS AND PREVENT OVERHEATING. The original 22" long stainless steel coal nozzle tip was replaced with a 33" section BY B+W. The COAL NOZZLE thermocouple ~~was~~ IS attached near this carbon and stainless junction. The control room has an indication of these temperatures and they have been set to alarm at 1350^{0}F. These temperature readings will be referenced later in the report as "burner temperatures".

IPSC has been instructed ~~over the past couple of years~~ by the boiler manufacturer to ~~continue reducing~~ REDUCE the amount of cooling air to the out-of-service burners in order to meet performance guarantees. This practice has resulted in burner component overheating and is the major reason for ~~the~~ past ~~failures~~ PROBLEMS and the present poor condition of the burners.

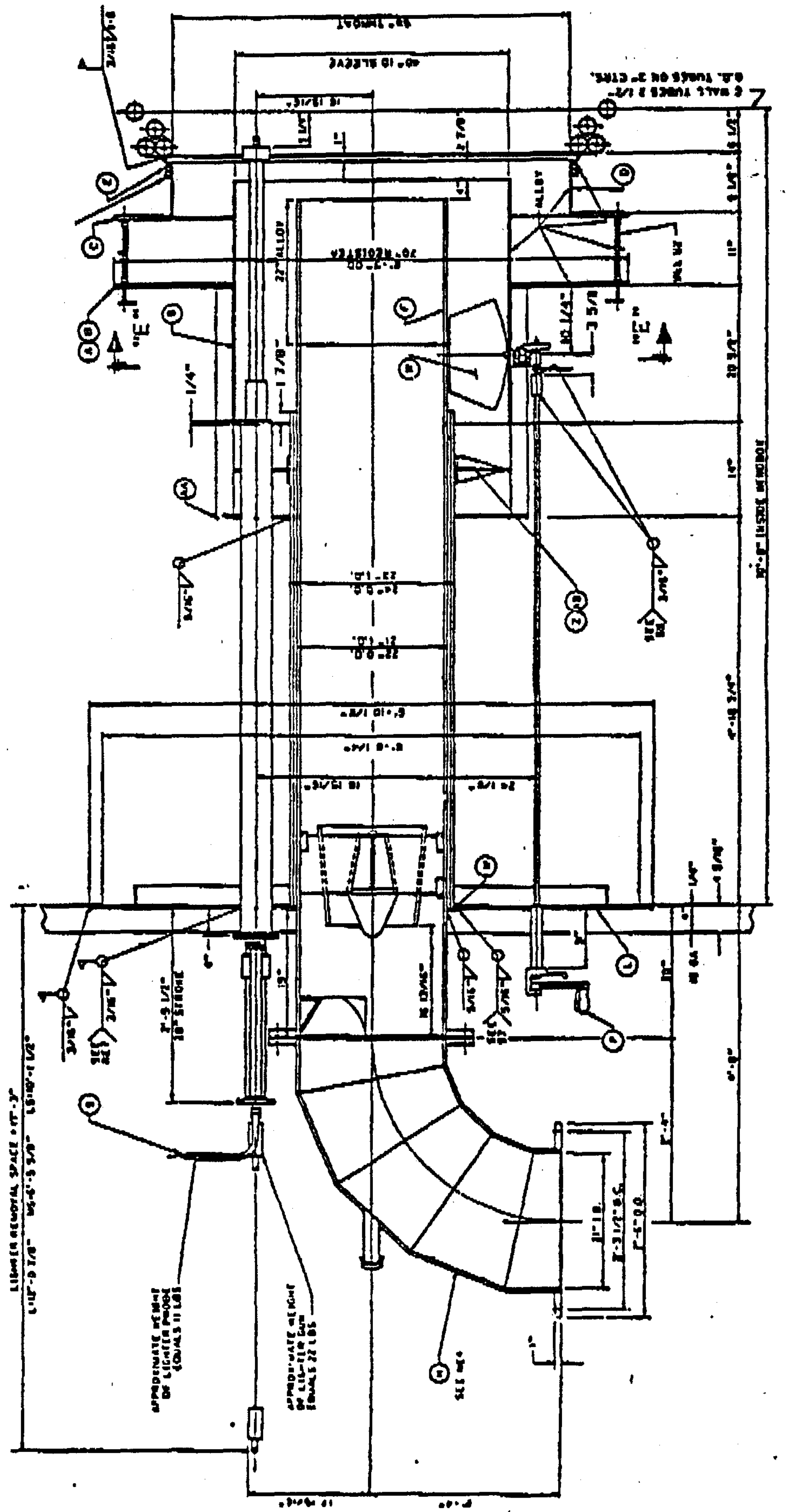


Figure 2

3.0 BURNER ~~EVALUATION~~

This section summarizes the visual observations that were made during the 3-27-90 outage ON UNIT 1, and the estimated remaining life of the burners. It should be noted that all observations, recommendations, and conclusions are based on visual information only. ?

3.1 Burner Inspection

SEPARATE SECTION

All forty-eight burners on Unit ~~#~~1 were inspected on March 27, 1990 by EER personnel WHO? ~~.~~ The burners were inspected from inside the windbox. A burner inspection sheet was completed for each burner to note the condition of each major component. Conditions such as warpage, exfoliation, overheating, weld breakage, and general operability were noted for each burner. A ~~typical~~ SUMMARY OF ALL burner PROBLEMS IS ~~inspection sheet is included as~~ SHOWN IN AN ~~the~~ figure 3. (INCLUDE INDIVIDUAL SHEETS IN APPENDIX)

Operators and maintenance workers WHO? were also interviewed to gather information concerning operating history and practices. TITLES OF INDIVIDUALS INTERVIEWED.

3.2 Existing Burner Conditions

QUANTIFY OPERATIONAL IMPACT.

The general condition of the burners at this time is very poor. Subsequent to initial ~~installation~~? numerous attempts to correct the problems which have arisen ~~have~~ left the burners looking severely mistreated. All the register doors have been air arced (Photos #1 & 2) to allow door movement when the register plates overheat and become severely warped. A triangular section has been removed along each door side that varied from one to two inches in width, and from the door tip to almost the door shaft in length. It appears that about 20% of the register door has been removed. The register doors also still have curved edges as a result of warped register plates before the door edges were trimmed. Many register door shafts are also bent and rotation appears difficult.

WHAT WOULD MIN/MAX TOLERANCES BE?

The OUTER register~~s~~ ASSEMBLIES have all been cut free from the inner air sleeve (Photo #4) so that the registers can move independently from the rest of the burner. The throat sleeve has also been cut free from the register front plate. Metal clips were ~~retrofit~~ SPELLING in an attempt (Photos #5 & 6) to hold the throat sleeve in place. UNCLEAR?

IP7_004283

Figure 3

Date: ______________
Insp: ______________

Burner # ________

	Condition				Warpage			Comments
	Gd	Ok	Pr	rr	No	Yes	Severe	
Casing								
Packing								
Register								
Front PL								
Rear PL								
Doors								
Shaft								
Linkage								
Spin Vane								
Bell Crank								
Linkage								
Sleeve								
Sliding Slv.								
Back PL								

PREPARE SUMMARY SHEET FOR ALL 48 BURNERS SHOWING PROBLEMS ON EACH.

NUMBER ABOVE ITEMS ALSO

The register is presently supported in only three locations. One is at the top of the inner sleeve, and the other two are supports from the register front plate (Photo #7) to the register support bracket. This support system promotes individual movement of the register plates which results in weld failures.

~~Specifically, the~~ Burner inspection sheets ~~revealed~~ WERE COMPLETED ON ALL 48 BURNERS The following problems WERE APPARENT:

OBSERVATIONS:

PLACE IN PRIORITY SEQUENCE

1. The throat sleeve and the throat sleeve casing on all forty-eight burners needed repair or replacement. B & W Construction was making these repairs during the burner inspections. The rope seal packing was virtually non-existent. This was allowing large quantities of air to escape into the furnace and avoid flowing through the burner. Also, approximately 90% of the welds connecting the throat sleeve casing to the furnace wall (Photos 8 & 10) were broken. The casing was free to move in any direction and this caused large gaps (1-2 inches) for air leakage into the furnace. A conservative 1" gap around the burner would amount to 3.5% of the throat area. DERIVATION OF ABOVE NUMBERS!

2. The support channel connecting the register front plate to the register support bracket was bent (Photo #7) and unable to slide freely on ten burners. This was caused by insufficient clearance between the retainer and register support bracket. The bending of the support channel distributes additional stresses to the register front plate which enhances the warpage of that plate.

3. The burner register or the throat sleeve was misaligned with the bent tube opening (Photos #15-17) on eleven burners due to warpage.

4. The register front plate was warped (Photos #18-21) on fourteen burners.

5 The register rear plate was warped (varied from 1/2" to 1") on twenty-six burners (Photos #22 & 23).

6. The welds were broken on the bar that connects the register front and back plate together on four burners. Burner C4 (Photos #24 & 25) had six of these bars broken and the back plate had subsequently warped at least 6". X SAFETY CONCERNS ON FAILURE

OTHER PROBLEMS: - LINKAGE + REGISTER SETTINGS NOT CONCENTRIC OR UNIFORM. ETC.

7. The register handle and quadrant were bolted together to prevent any adjustment so register doors could not be stroked to determine ~~on~~ of freedom of movement. The register doors were stroked a small amount (play in linkage) from the windbox. It was noted that three burners had register linkage that was locked tightly and would not move at all.

8. The stiffener bars that are welded to the outside of the inner air sleeve (Photos #26 & 27) showed signs of overheating on twenty burners. Large flakes of metal BROKE AWAY FROM THE BURNER WITH ONLY FINGERTIP CONTACT. ~~could be removed by using only fingers~~. This was not caused by cutting or field alterations since it was not found on all burners. The maximum recommended working temperature of this material had undoubtedly been exceeded. Also, one burner had broken welds where the stiffener bar attached to the inner air sleeve.

9. The weld that connects the pull handle to the inner air zone disk was completely broken on one burner (Photo #28). Another inner air zone disk was cocked at an angle from vertical and was being held there by the pull handle.

I.E. INSUFFICIENT COOLING AIR FLOW

10. A general observation that was noted on each burner level was that the middle burners had definitely experienced higher temperatures than the outside burners. The physical evidence made it appear that the middle burners are receiving less cooling air when taken out-of-service. (IN CONTRAST WITH I/S BURNER PROBLEMS OF GETTING BALANCED AIR FLOW TO OUTER BURNERS.)

3.3 Estimated Remaining Burner Life

SEPARATE SECTION

Considering the current burner condition and the amount of deterioration that has taken place in less than five years, ~~the estimated remaining burner life is expected to be less than five years~~ ESTIMATED TOTAL LIFE. It is expected that the majority of the burners will have major failures like burner C4 (Photos #24 & 25) if the burners continue to operate at the present temperatures and conditions. It is estimated that a significant effort will be necessary to rebuild the burners to maintain operating conditions. The burner failures will consist mainly of register and throat destruction. It should also be noted here that temperature variation around the burner exists. A thermocouple on one side of the burner may not be

NEED FULL ECONOMIC EVALUATION

alarmed to indicate excessive temperatures, but if the thermocouple was placed in a different radial position around the burner, the recommended temperature would be exceeded. These thermal gradients produce high thermal stresses that cause the severe warpage.

3.4 Estimated Remaining Life of B & W Burner Fixes ?

In the first ~~year~~ FEW YEARS of service, many repairs were necessary on the original burners. These repairs were required due to ORIGINAL manufacturing deficiencies and installation errors. Since then, failures are a result of excessive temperatures and stresses. Numerous alterations have been made in an attempt to keep the burners operating. New throat sleeve casings were installed, but the basic design has remained the same. Therefore, there is no basis for expecting this repair to function any longer than the last.

NEED LISTING

4.0 ALTERNATIVES ~~CONCLUSIONS AND RECOMMENDATIONS~~

REVIEW ALL OPTIONS
5 SPECIFIED IN
NEW TABLE OF CONTENTS

The size of the 70" register greatly exceeds any other previous register sold by B & W. The diameter of this register was increased from the previous standard size while all plate thicknesses, material specifications, and manufacturing processes remained the same. This has created two problems. The burner temperatures are higher than expected even using the "normal" amount of cooling air, which can be attributed to increased radiant heat transfer through the larger throat area. The other problem is that higher combined (thermal, residual, bending, etc.) stresses are greater. The combination of higher stress and temperature have produced the higher than expected rate of deterioration.

Two ways of correcting the unacceptable conditions that plague IPP Units #1 and 2 are as follows:

MORE DETAIL

1. Replace damaged components on the existing burner. Subsequently, reduce burner temperatures by increasing the amount of cooling air. Stainless steel materials should be limited to 1150°F, and carbon steel to 850°F.

COST / η BOILER + HR

2. Install a new burner DESIGN that will operate with an acceptable life expectancy at ~~a~~ THE higher temperature. ~~that is deemed necessary.~~

4.1 Repair Existing Burners/Revise Temperature Limits

MISPLACED QUANTIFIABLE? REFERENCES?

Past burner experience indicates that reducing the maximum temperature to 1150°F on a new burner will result in an expected burner life of twenty to twenty-five years. Although the maximum operating temperature (with regard to oxidation resistance) of the stainless steel material is several hundred degrees higher, the creep strength is greatly reduced at elevated temperatures. Creep strength is the ability to resist permanent strain that increases as a function of time under stress. Depending on the source, the creep strength of ~~a~~ AISI 304 stainless steel is approximately 9.5 KSI at 1150°F and 3 KSI at 1350°F. Figure 4 illustrates the creep strength vs. temperature relationship for 304 stainless steels.

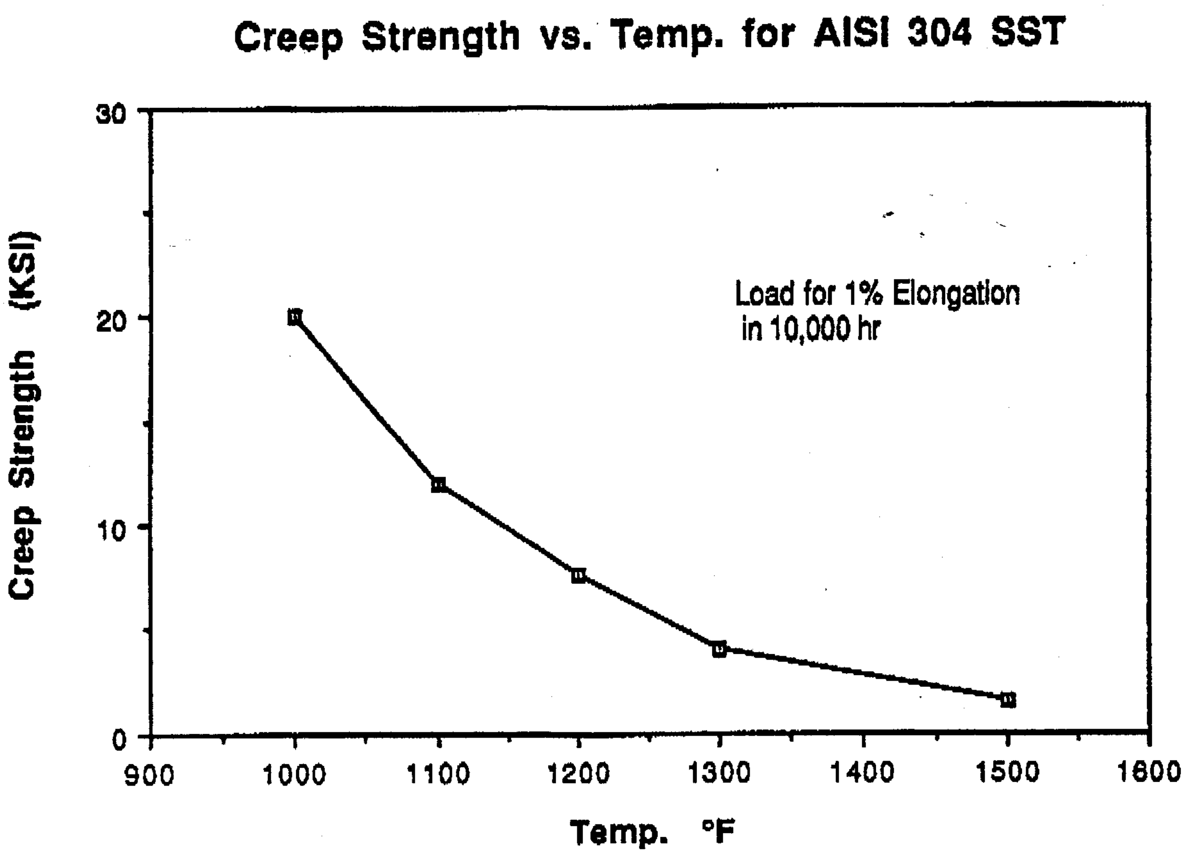


Figure 4

The register should be better supported regardless of the operating temperature. Freedom to move independently of the inner air sleeve is good, but the register rear plate should also be supported off of the register support bracket as is the front plate. Round edges and adequate clearances should also be incorporated into the register support bracket retainer to assure that the register assembly can expand as needed.

SECTION MISPLACED

VERY UNCLEAR ?

The conclusion of this ~~report is~~ that new H.D. type registers should BE INSTALLED ON ~~replace~~ all burners on the lower three levels on IPP Units #1 and 2. The current condition of the existing burners warrant the change because they have a short life expectancy.

These new H.D. registers also need some additional structural changes as evidenced by the current H.D. registers that have been installed in the upper row of burners. Some warpage has transpired since installation and this problem needs to be taken care of by additional materials or a stronger material. The registers should also be of a one-piece design which would require that the burners be pulled back far enough for installation over the inner air sleeve. The two-piece design registers that were installed on the upper row of burners is not compatible with good register design.

New throat sleeve casings should also be installed on all burners. The casing needs to be redesigned to allow for the large thermal expansion that wants to take place. This will eliminate the extreme warpage and weld breakage.

4.2 Replace Existing Burners

If increased cooling air quantities are unacceptable and burner temperature limits cannot be lowered, the existing burners should be replaced with burners designed to operate at the present temperature levels. New material specifications would be required. A higher grade of stainless steel such as AISI 309 or 310 with a low carbon content would be better suited for high temperatures and welded constructions. This material would provide a higher creep strength and also alleviate long-term effects of weld decay (Appendix A). Material thickness would probably also need to be increased to overcome the high stresses that are occurring. Thermal expansion problems also need to be addressed. The size and operating temperature of this burner dictate that large thermal expansions occur. If these expansions are restrained, then additional material and supports will be necessary to withstand the high resulting stresses. Preferably, the burner would be designed to allow individual parts to expand without constraints.

5.0 ESTIMATED COST

INTEGRATE INTO ALTERNATIVES + COST SUMMARY

– NEED / FOR EACH OPTION

– BREAKDOWN NEEDED!
MTL –
LABOR –
ENG –
SHIPPING –
ETC.

The estimated material cost of new registers and casings to repair the existing burners would be $5,600.00 per burner at this time. This cost does not include OEM mark-up. The estimated installation cost would be $10,000.00 per burner, inlcuding EER construction supervision. REMOVE

The cost to completely replace the existing burner registers and casings with "higher temperature" designs would be $7,000.00 per burner.

DETAIL NEW DESIGN

– MODS,
– MTLS.